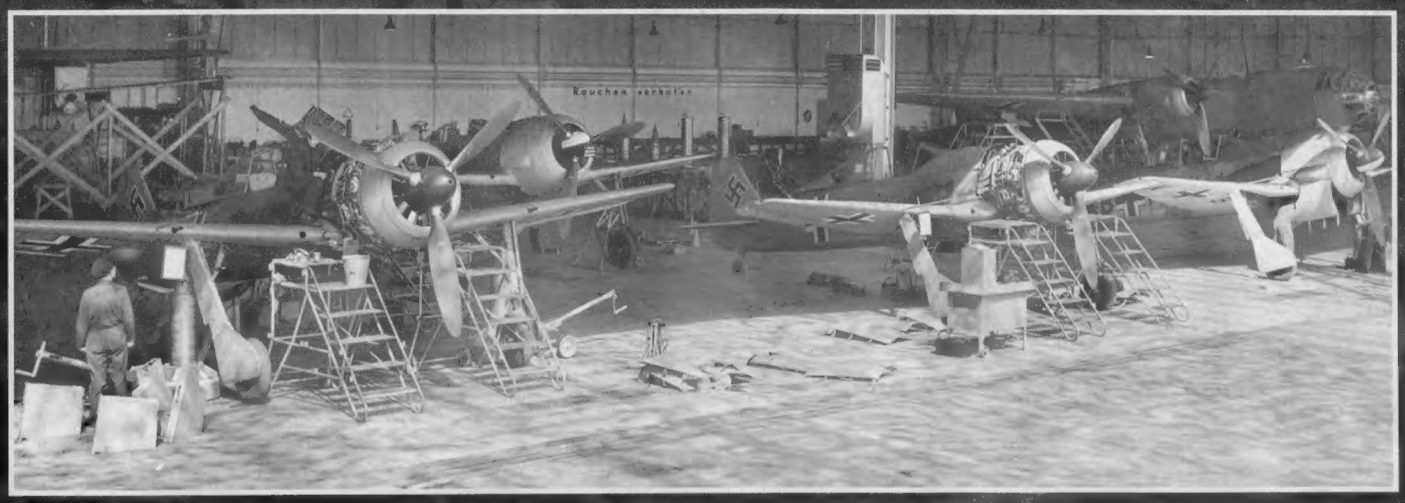


# The DEVIL'S WORKSHOP

**By Joe Mizrahi**

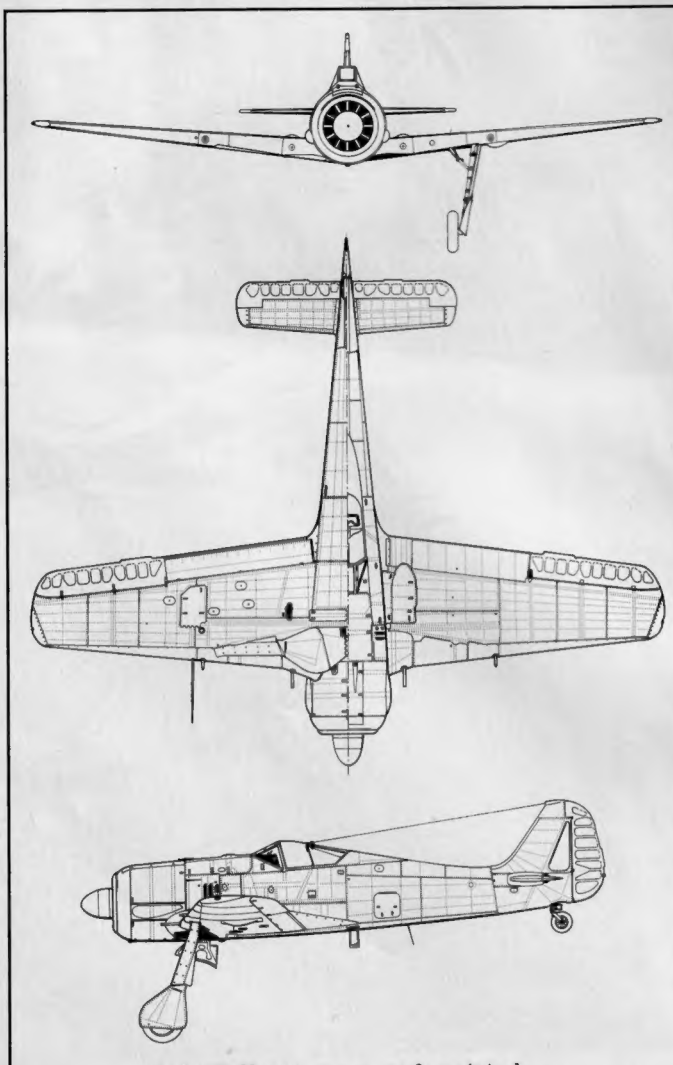
*These Exclusive Photos, Many Of Which Have Never Before Been Published, Were Made Available Through The Generosity Of John Batchelor, Noted Aviation Artist And Longtime Friend. Using Similarly Detailed, Historically Accurate Photographic Sources, Which Invariably Characterize His Work, John Has Become An Acknowledged Leader In Aircraft Cutaway Representations.*

## A Revealing Walk Around A Focke-Wulf 190 Shop Floor For An Inside Look At How Germany's Best Mass-Produced Fighter Of World War II Was Built!

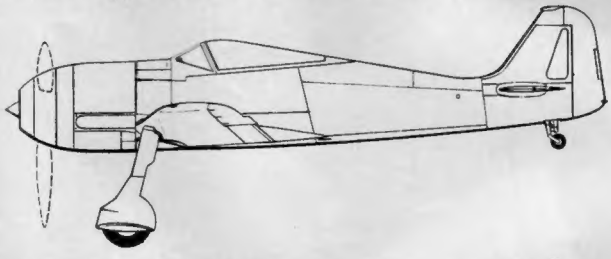
**Top Photo: The flight line hangar at Warnemunde, Germany, with scattered cowl panels on the concrete apron in front of the aircraft and maintenance stands. In background at right is a view of the Focke-Wulf 191 pressurized bomber, which eventually lost out to the Junkers 288. Six prototypes were built, before work terminated in 1943.**

**Above: Their cannon armament not yet fitted, early Fw 190A–2 or A–3 models are shown at the Arado Warnemunde plant in 1942. Of interest is the opened lower cowl side panel with its system of three locking toggles which was duplicated on all panels surrounding the cowling, allowing for quick access, as seen in second aircraft with engine exposed.**

**A Focke-Wulf 190A–2 was to have been the first true production version of the fighter designer Kurt Tank gave the name *Wurger* or Shrike to. This one demonstrates that several of these A–2s were not true production aircraft. It has a pair of cowl-mounted 7.9mm Rheinmetall machine guns, but instead of two Mauser 15mm automatic cannon in the wing roots, the ports for their barrels remain empty. Instead, a pair of older, drum-fed 20mm Oerlikon guns has been installed in wing outboard of the landing gear. In later A–3 versions, the Mausers were upgraded to 20mm and installed on all aircraft.**

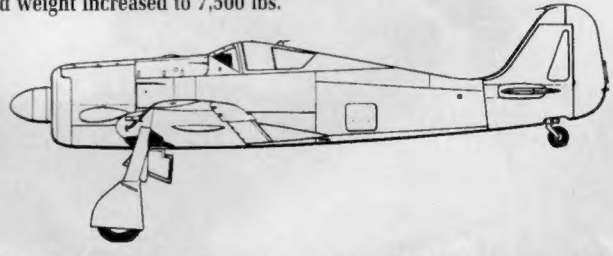


**Focke-Wulf 190A–3, span 34 ft. 5-1/2 inches. Length 28 ft. 10-1/2 inches. Loaded weight 8,770 lbs.**



**Above: The first Fw 190 prototype with ducted spinner and smaller BMW 139 engine, with a loaded weight of 4,000 lbs.**

**Below: The fifth V–5 prototype variant with longer 34 ft. 5 inch wing span, more powerful BMW 801 engine, elongated fuselage and weight increased to 7,500 lbs.**



subcontract work for its better known rivals. It also became a principal center for armament configurations and gun mountings. In several of the photos illustrating this article, you will note a few prototype aircraft, such as the first FW–191, a twin engined bomber, shown behind a flight line hangar filled with Fw 190s; you will also see rows of Focke-Wulf 189 tactical reconnaissance machines interspersed with some of the nearly 4,000 Fw 190s delivered by the Warnemunde complex.

That facility, which employed nearly 15,000 workers, also built half of the 1,000 Heinkel He 177 heavy bombers delivered to the Luftwaffe. The majority of photos illustrating this article were probably taken between 1942 and 1944. During the earlier period, two Fw 190A–5s, to be used as prototype bomber destroyers, were given a pair of heavier 13mm cowl-mounted machine guns – firing a bullet approximately 100 grains heavier than a U.S. .50 caliber round – in place of the standard 7.9mm (.30 caliber) weapons. This gun arrangement, for which the Warnemunde factory did the engineering, would become standard on all later Fw 190A–8s, the last production A-series variant and the one built in larger numbers than any other sub-type.

Editor's Note: The Focke-Wulf 190 fighter has been the subject of several *Wings* & *Airpower* features, some of which are still available in back issue. Among those are: *Wings* February, 1982, February, 1984 and October, 1997.

The sheer volume of articles on the Fw 190 speaks to its ongoing popularity among readers. But, while previous offerings traced the history of its development, its performance and use in combat, this presentation is different. It takes you directly into Arado's Warnemunde factory, one of two major license-builders of Germany's World War II workhorse fighter, to show you how it was manufactured.

Together with the main Focke-Wulf plant at Marienburg, Arado and AGO – another major subcontractor – were responsible for most of the more than 20,000 Fw 190s assembled from components supplied by dozens of subsidiary facilities. Warnemunde, the primary Arado factory for Fw 190 production, which included 161,000 sq. ft. of covered space, was located on the Baltic Sea, not far from the port of Rostock, and approximately 100 miles north of Berlin. It had built aircraft components during the last year of World War I and was purchased in 1921 by industrialist Hugo Stinnes, an early Nazi supporter, who later fled Germany. In 1933, it was upgraded and taken over by Germany's Air Ministry, its first aircraft, an Ar 66 trainer, coming off the assembly line one year later. Over the next few years it license-built the designs of others, while Arado expanded its facilities to six other sites, the most modern being Brandenburg-Neuendorf, outside Berlin, which concentrated on new designs. After turning out Junkers Ju 88s, this factory would be responsible for the world's first operational jet bomber, the Arado 234. For the full story of Arado and its aircraft, see two-part article in *Airpower* May and July, 1990, available in back issue.

Setting up for Fw 190 production at Warnemunde began early in 1940, with deliveries to operational units commencing in August, 1941. Prior to that time, the Warnemunde plant had been turning out Messerschmitt Me 109 fighters, again under license, and strangely enough, the most successful of Arado's own designs, the advanced Ar 96 monoplane trainer, was built almost exclusively by AGO, its partner in Fw 190 production.

For most of the war, Arado was engaged primarily in assembly and

When first proposed as a successor or follow-up to the Messerschmitt Me 109 in the spring of 1938, the Focke-Wulf 190 was to have been powered by a liquid-cooled engine supplied either by Junkers or Daimler Benz. But designer Kurt Tank and his team of engineers, including R. Blaser, wisely decided to take advantage of a powerful new 1400 hp. radial engine from BMW, the eighteen-cylinder 139, and offer an alternative fighter. Liquid-cooled engines, with their smaller frontal area, might lessen drag by lending themselves more easily to streamlining, but they were much more vulnerable to battle damage. Furthermore, they were sought out and specified by so many German airframe manufacturers, that they would be in short supply.

Even though the Luftwaffe's Technical Branch was not particularly enthused by Tank's proposal, that fall it ordered three prototypes of his new radial-engined fighter. What resulted was a beautifully proportioned, extremely compact design, its bulky air-cooled powerplant nicely blended into a slim fuselage. But there were problems.

The pilot was too close to the engine. Its placement left insufficient room for the cowl-mounted weaponry most favored by Luftwaffe procurement, and this close proximity to the engine itself resulted in sweltering cockpit temperatures. With the first prototype completed and the second rapidly nearing final assembly, the emergence of a newer and more powerful engine from BMW, the 801, promised to rescue the project, but also presented new challenges.

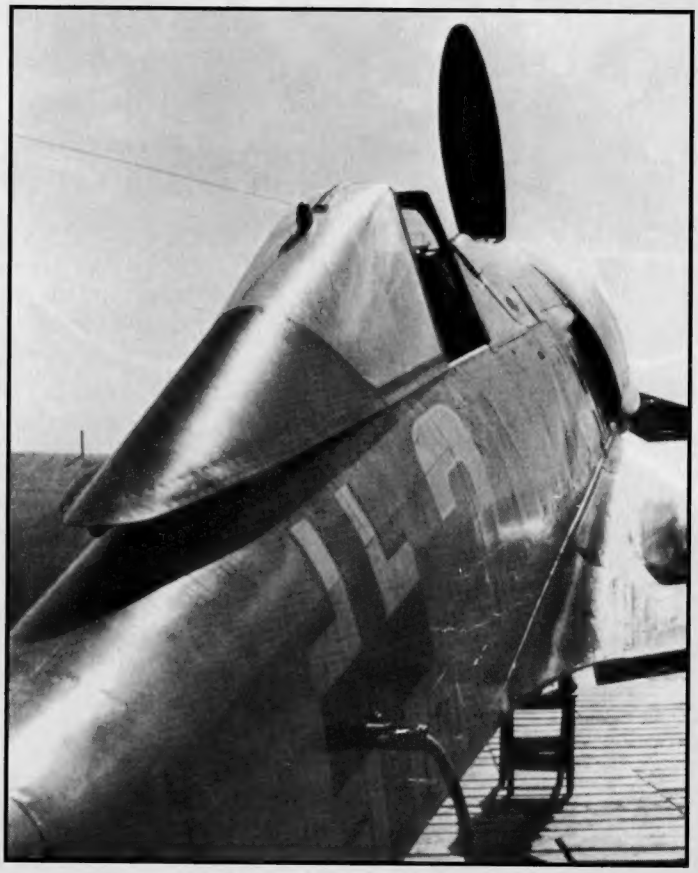
Although it had the same diameter as the 139, the twin-row, 1700 hp. BMW 801 was also longer and heavier, weighing 2,300 lbs., 350 lbs. more than its smaller cousin. Installing it necessitated pushing the cockpit farther back and reducing it in size. This partially alleviated the overheating problem, but also entailed a larger, extensively redesigned airframe, now fitted with armor plate, a modified canopy, revised rudder contours, beefed up and repositioned landing gear, relocation of the wheel wells, and forward extension of the wing roots, all within a fuselage increased by just four inches. Marked improvements in performance were promised, but the revised prototype now weighed 7,550 lbs.

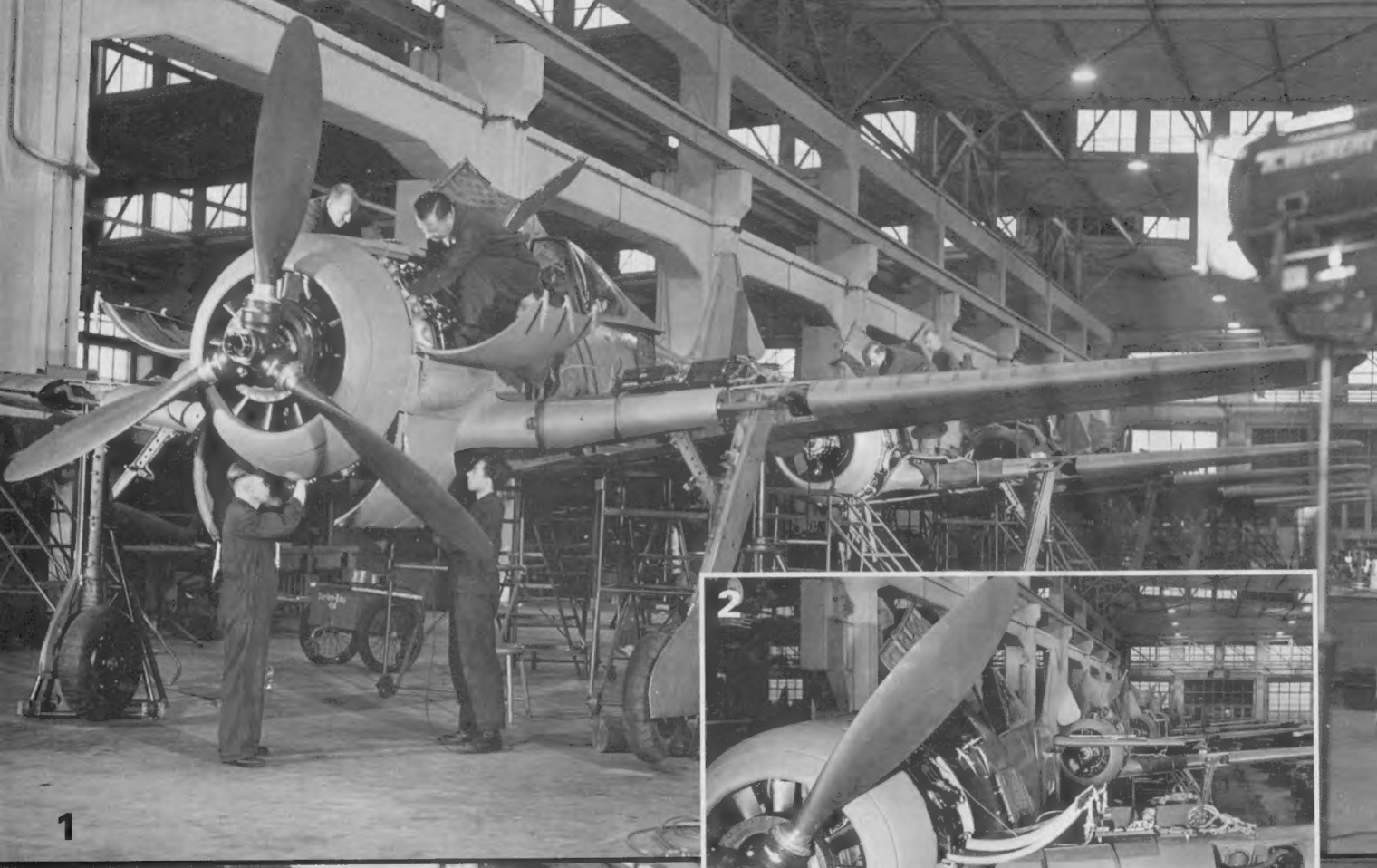
The first Fw 190 prototype, with its experimental ducted spinner to reduce drag, had a loaded test weight of less than 4,000 lbs. The second, with minimum armament, weighed 4,400 lbs.; and although test pilots exulted over their handling and maneuverability, continued complaints about cockpit temperatures and gas fume leaks which forced them to keep the canopy closed and fly on oxygen at all times, precluded acceptance of the aircraft in its then present form. Focke-Wulf's engineers believed that marginal engine cooling, which did not seem to reach the top row of rear

*(Text continued on page 42)*

**Above: Interior view of the Focke-Wulf Marienburg plant shows Fw 190A–3s, recognizable by their horizontal, forward-facing radio antenna aerial attachments stubs atop fin, as opposed to vertical shaped stub in subsequent models. In an effort to improve cooling, louvers on panel covering engine exhaust pipes have been installed on forward fuselage behind side cowling. In center background is a twin engined Messerschmitt 110; at left a transport version of the Focke-Wulf 200 Condor with complete airliner windows. Shortly after this photo was taken all major production was switched to Arado and AGO.**

**Below: Despite bulkiness of its radial engine, Fw 190 had elegant fuselage lines. Here, it has its batteries charged by portable generator. Top two of four longerons, which ran aft from the No. 1 bulkhead, dividing the engine firewall from the cockpit, also served as tracks for the sliding canopy.**





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1 & 2. The three locking heavy toggles, which characterized the Fw 190's detachable cowling also served as a light workbench. Although they could be removed, they usually remained attached to the aircraft during servicing and were ready for quick locking to allow for immediate take off.

3. Immediately aft of the engine mount's top fittings, a shelf was formed for the fuselage machine gun installation. Attached to this and opening to the rear was a hinged aluminum alloy panel of waffle construction which moved forward to enclose the weapons. The dual skins of the waffle panels were fastened together by a single rivet in each skin's dimple, giving Fw 190 construction a characteristic look. This same dimpling was found in the tail wheel access panel, radio access compartment, in various access panels to the ammunition wing bays and in the rear sections of the cowling, above the supercharger ducting.

5

4. Multiple panels open, a line of Focke-Wulf 190A–3s shows off underwing bulges housing the MG 151/20mm cannon feeds. Air-cooled, belt-fed Mausers used disintegrating push-out links and had a rate fire of 650 to 700 shots per minute. Originally calibrated for 15mm ammunition, which under German nomenclature classified it as a machine gun, weapon was later upgraded to 20mm machine cannon. The former placed 93 lbs. of metal in flight with 200 rounds, the latter 190 lbs. at a ten-percent increase in rate of fire.

5. Fw 190 displays the oleo legs of its raked-back and wide-set landing gear. Front face of its mounting was flanged to bolt to wing's front spar. Open wheel well doors are shown below and behind cowl. In background, at right, is another view of one of the Focke-Wulf 191 bomber prototypes. Of interest are the remotely controlled twin machine gun barbettes mounted in the trailing edge of its engine nacelle, with another flat-topped barbette seen to the upper left of the fin's swastika emblem.

cylinders, would be remedied appreciably by the installation of a ten-bladed fan, not available at the time of the initial flights, but it remained doubtful, given the placement of the cockpit to the engine, if the Fw 190 as designed would result in a successful contract to produce more.

In May, 1939, the new 801 engine was installed in two extensively remodeled V–5 prototypes, necessitating moving the cockpit rearward, which also improved the aircraft's center of gravity. Superficially, this and several accompanying changes didn't seem that drastic, but they were. In the process, the wing was re-engineered, but retained the profile of the original. Now built in one piece, it cut 300 lbs. from the aircraft's weight. It also came in two versions. One used the same dimensions as on the first two flying prototypes, and had a length of 31 ft. 2 in. The other was three ft. two inches longer and contained an additional 36-sq. ft. of wing area. This ten percent increase in span accomplished two things. At a loaded weight of 7,500 lbs., the revised V–5 short wing test machine's climb performance, maneuverability and speed suffered markedly when compared with the original. But with the longer wing, the excellent climb and maneuverability displayed by those first prototypes, despite 3,000 lbs. of additional weight, was restored, while top speed declined by only 6 mph.

As a result of these tests, beginning early in 1941, the eighth production machine, already under construction, became the standard for all future Fw 190A–1s being readied for armament testing, delivery, service acceptance and squadron orientation.

At this point, Kurt Tank was tasked with tooling up for joint mass production at Focke-Wulf, Arado and AGO. Fourteen of the first 40 examples were kept back as development aircraft. Six went to Luftwaffe service test centers, all arriving by the end of April, and the Second Group of Fighter Wing 26 was chosen as the first unit to receive the newly minted fighter.

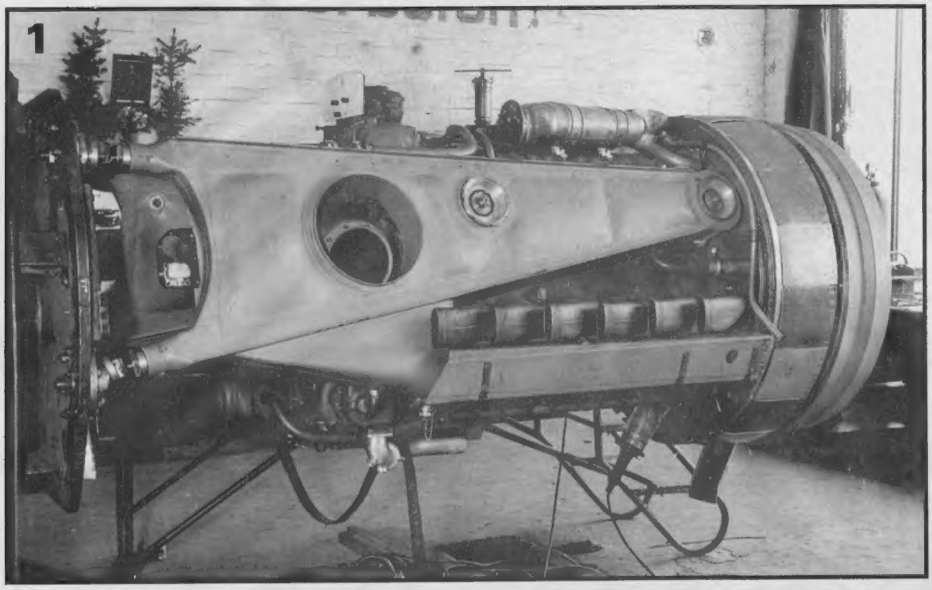
As the summer of 1941 waned, II/JG 26 began receiving its first aircraft, one that could roll better than any contemporary adversary and perform aileron turns that would have torn the wings

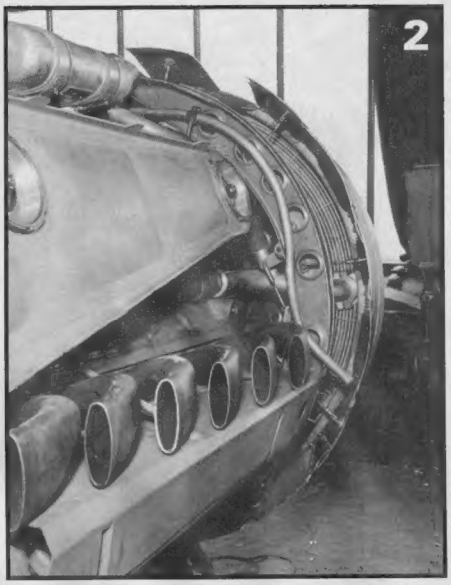
**Above: Mechanics install the three-bladed VDM adjustable pitch constant-speed propeller, its shaft fitting into 6.5mm armored cowl ring, which also incorporated the twelve-blade engine cooling fan, a hydraulic-electric pitch control unit, magnetos, thermostat, annular oil tank and primer fuel lines. Characteristic bulge below the mid-line of the side cowling on left housed the oil pump. Bulge on opposite side housed airflow ducting for cooling engine's rear cylinders.**

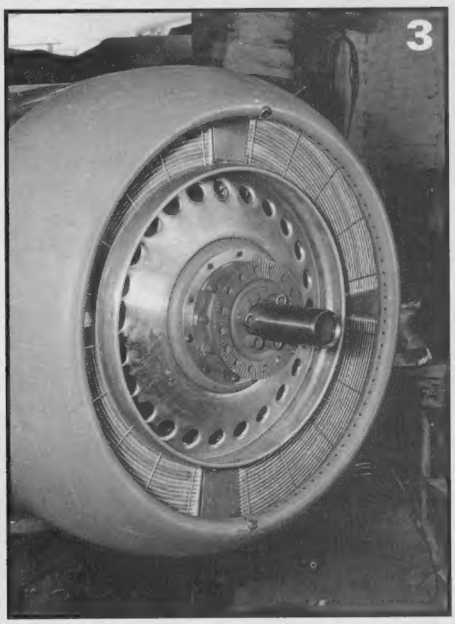
**Top Right: Early Fw 190A–3 models, with Messerschmitt Me 110 in left background. Louvers behind cowling served as exit for hot exhaust. Bulge on wing root, at inner junction of wing's split flaps, covered feed for right wing MG 151/20 cannon. Aileron activation control linkage can be seen immediately below wing's Maltese Cross national insignia.**

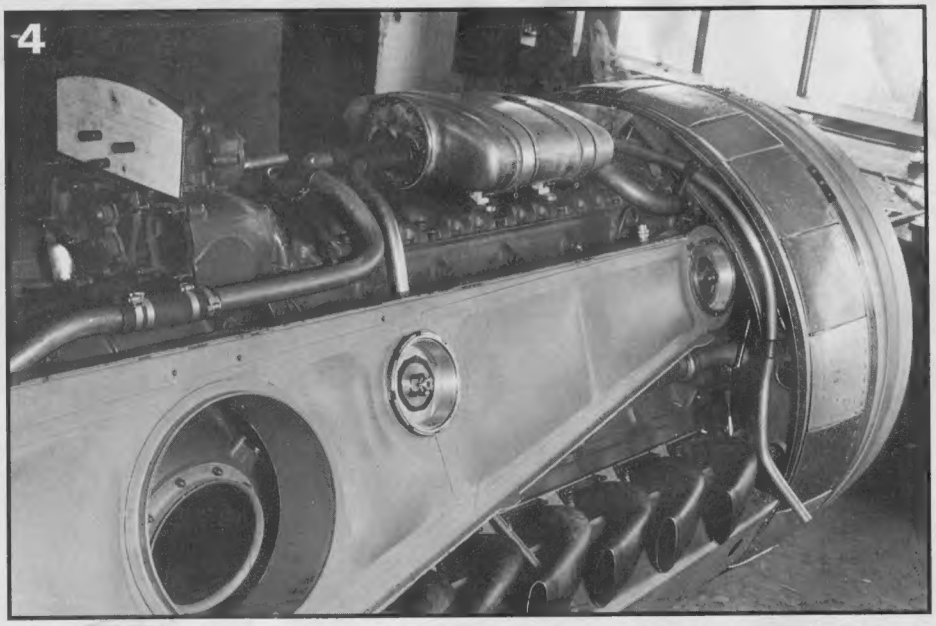
**Right: Dozens of bare fuselages, together with basic wing assemblies and BMW 801 radial engines await mating on the Warnemunde line. Unlike the U.S. system where assembly was completed by workers and then checked by foremen or supervisors, German, like British construction, was based on a series of loose assembly, finished off by more experienced fitters, who made final connections. In background, behind the Fw 190 components, are a dozen Fw 189 three-seat, twin engined tactical reconnaissance and army cooperation aircraft, most of which were built at the company's Bremen plant. They are at Warnemunde for armor glass and weapons modification, at which the plant excelled.**

from an Me 109. It also possessed excellent dive speed. Combined with finger light maneuverability and little need to retrim in differing stages of flight, it could operate effortlessly at 400 mph. plus, with a top speed of 418 mph. at 21,000 ft. Soon to be heavily armed with two light machine guns and up to four 20mm wing cannon, it was extremely comfortable, with a semi-reclining seat ideally suited to high G maneuvering. The fighter accelerated rapidly and was far easier for new pilots to transition into than the older Me 109. Maintainability was simple and straightforward, with nice engineering touches in devising the cowl for easy access. The Fw 190 was dependable and its long-legged, wide stance land-









1. A completed BMW 801 engine ready for installation. Cylindrical metal structure on top is the supercharger air pressure pipe. Triangular-shaped forged engine bearers and their anti-vibration mountings are seen just above the engine's exhaust stubs.

2. View looking forward toward annular oil cooler ring in open position, above cowling support ring, with ends of exhaust stubs below, nearest camera.

3. Forward view of cowling showing interior of armored ring, cooling fan, propeller attachment point, annular oil tank and openings to enhance airflow.

4. Another view of engine showing supercharger air pressure pipes, wing root cannon synchronization gear leads, cowling support ring, forged engine bearer and cockpit heating pipe just touching first stub exhaust.

5. Good view of the three toggle locks on cowling covering magnetos and rocker boxes, with cooling louvers on panel aft of exhaust stubs. Cable on wing root connects to electrical junction box.

ing gear tracked and handled well on the ground. Perhaps most important, its durable structure was optimized from the first for mass production, being built up from subassemblies supplied by a host of small manufacturers, whose factories could be easily dispersed, and eventually were.

Despite these praiseworthy traits, this exciting, elegant new fighter, of which much was expected, had its shortcomings. Forward vision in the air was good, but poor during landing approach. It rapidly lost performance above 25,000 ft., and above 30,000 ft. was inadequate. While initial climb was good, at 23,000 ft. it fell off considerably. If the engine was lost, there was no way to glide the aircraft back to a safe landing, for without power it dropped like a brick. The finger light ailerons were prone to vibrating heavily, particularly in stalls, causing the aircraft to rock, and they lost their touch at high speeds, requiring full application of the controls, resulting in a wide side-to-side throw, with very little bite. Although control harmonization was just short of fantastic,

*(Text continued on page 50)*

6 & 7. Two views show final assembly and installation of the VDM adjustable-pitch propeller. In Photo 6, the propeller hub collars are being tightened. Multi-bladed fan within armored cowl ring produced a great volume of air for compression and cooling. Its absence on first two prototypes caused excessive overheating.

8. Another view of the Warnemunde flight line hangar. Aircraft are equipped with pitot tubes, but have not yet had armament installed.





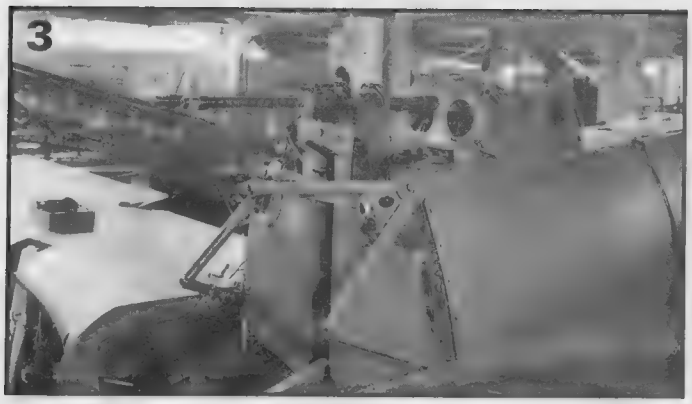
1. Overhead crane sits above a near completed Fw 190, which awaits armament. Strongest portion of tapering front wing spar was its center section, built up of triple web, heavily reinforced I-beams.

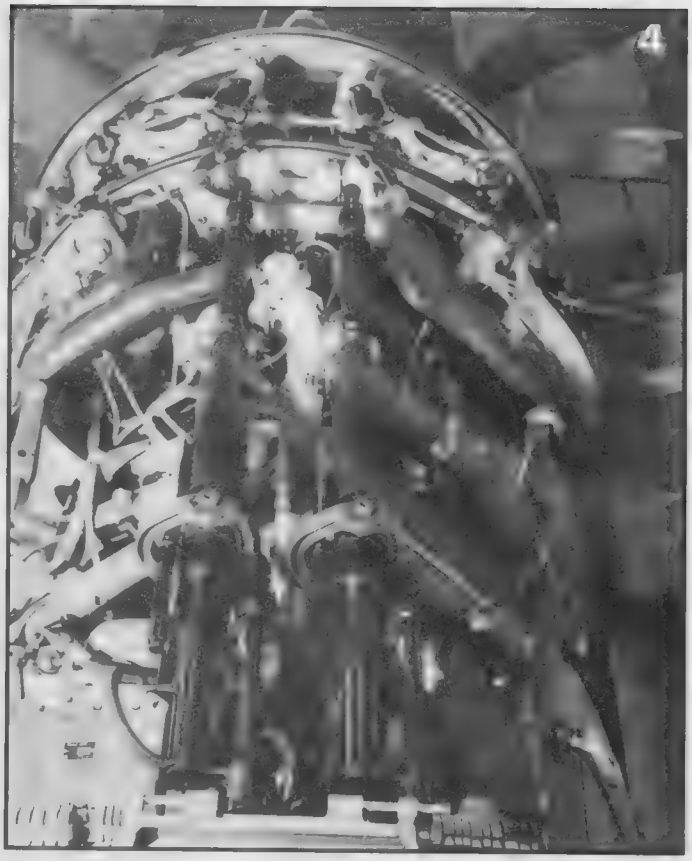
2. Landing gear installation. Unit was composed of a single strut oleo with torque scissors attached to a forged steel, tapered roller bearing spindle assembly. Here, again, skilled fitters complete and inspect final assembly.

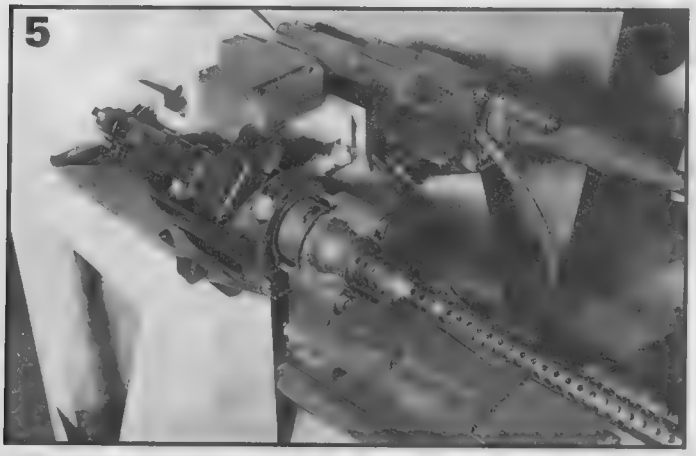
3. Early Rheinmetall 7.9mm machine guns in the cowling of the Fw 190A–2 through A–7. With a rate of fire of 1,200 rounds per minute, these weapons sat on a flat shelf, immediately forward of the windscreen and aft of the top engine mountings, their curved ammunition chutes fitting over the breeches, with synchronization gear directly ahead of the metal housings. Access was through a hinged panel at both sides.

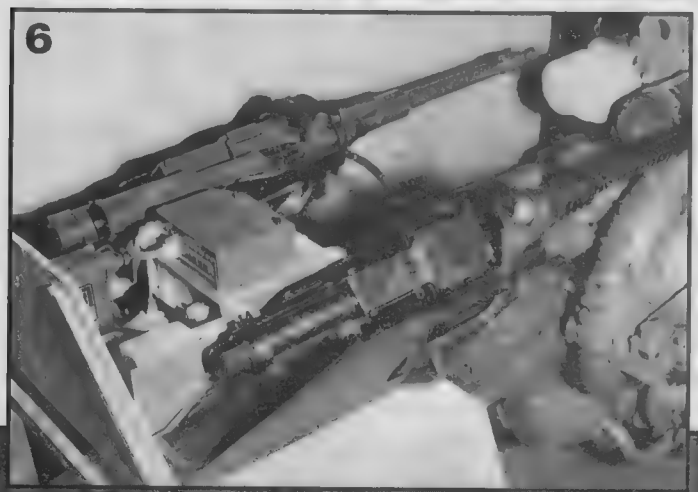
4. Compare this straight layout of smaller caliber 7.9mm MG 17s in earlier version of Fw 190 with that of tilted arrangement for larger 13mm weapons in Photos 5 & 6.

5 & 6. Stamped with the legend MG 131, these twin, belt-fed 13mm weapons from Rheinmetall indicate that installation is for either the two Fw 190A–5/U9 test machines, which served as trial aircraft for the upgraded modification, or they are being fitted to standardized A–8 fighter-bombers. Weighing just 40 lbs. each, the MG 131 was a superb weapon with a rate of fire of 900 rounds per minute and a velocity of 2,560 ft. per second. A counterpart of the U.S. Browning .50 caliber gun, it was one of the best weapons of the war. Unlike the MG 17, these guns were not mounted upright, front to rear, but tilted a few degrees outward, an arrangement that led to a slightly bulged top panel.









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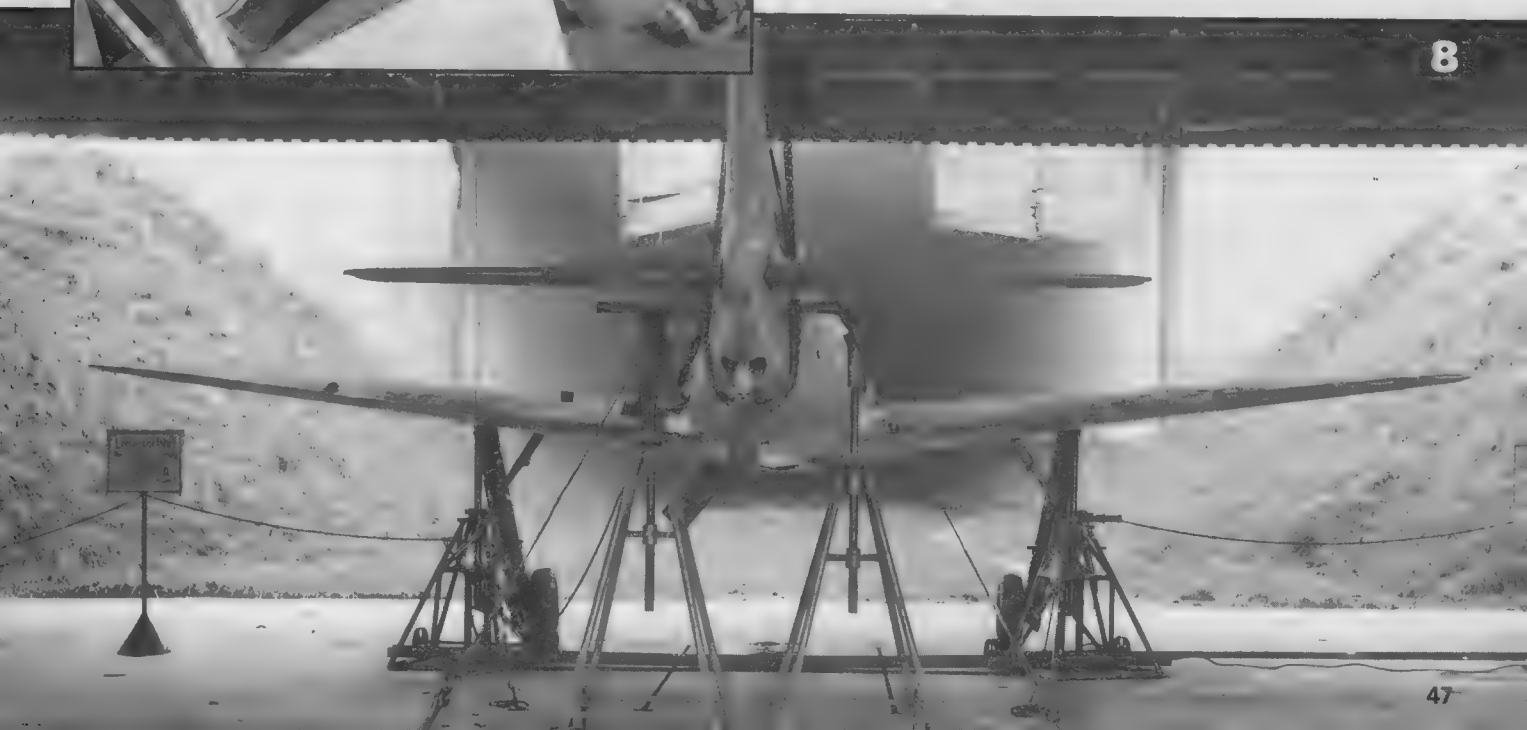
7. Rheinmetall MG 131, developed in 1938.

8. Completed Fw 190 is taken to the firing butts, its weaponry checked. Tail wheel is in down position, and was placed six inches behind its yoke mounting to permit castoring. Gravity and a heavy coil spring combined to pull the wheel down. It retracted with the main gear by means of a cable and pulley arrangement.



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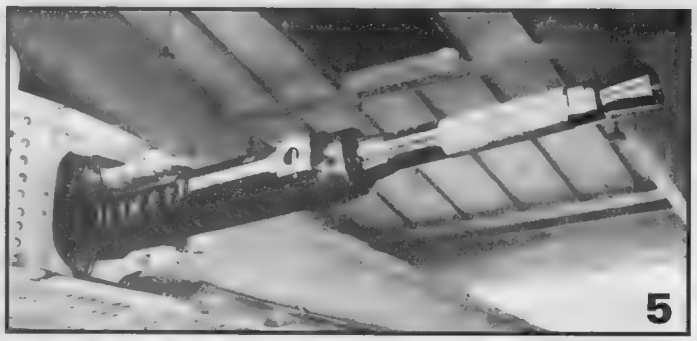
1. Late in 1942, with Fw 190 production at Warnemunde measurably increasing, the Arado factory began building new conversion sets to enhance the fighter's versatility. Most of these dealt with fighter-bomber missions. Shown here is the basic bomb-carrying version, the A–5/U8 with a 550 lb. bomb mounted beneath the fuselage, which served as a departure point for a number of such conversions.

2. To enhance range for reconnaissance and long-distance strikes, this A–5/U13 was equipped with racks for a pair of 75 gallon underwing fuel tanks and a ventral fitting to carry either an additional tank or a 550 lb. bomb. Of all photos in this article, this one, accompanied by a factory history worksheet, lists all modifications made (19 in all) to this particular test aircraft, as well as their dates, beginning in September, 1943 and ending in December, 1944.

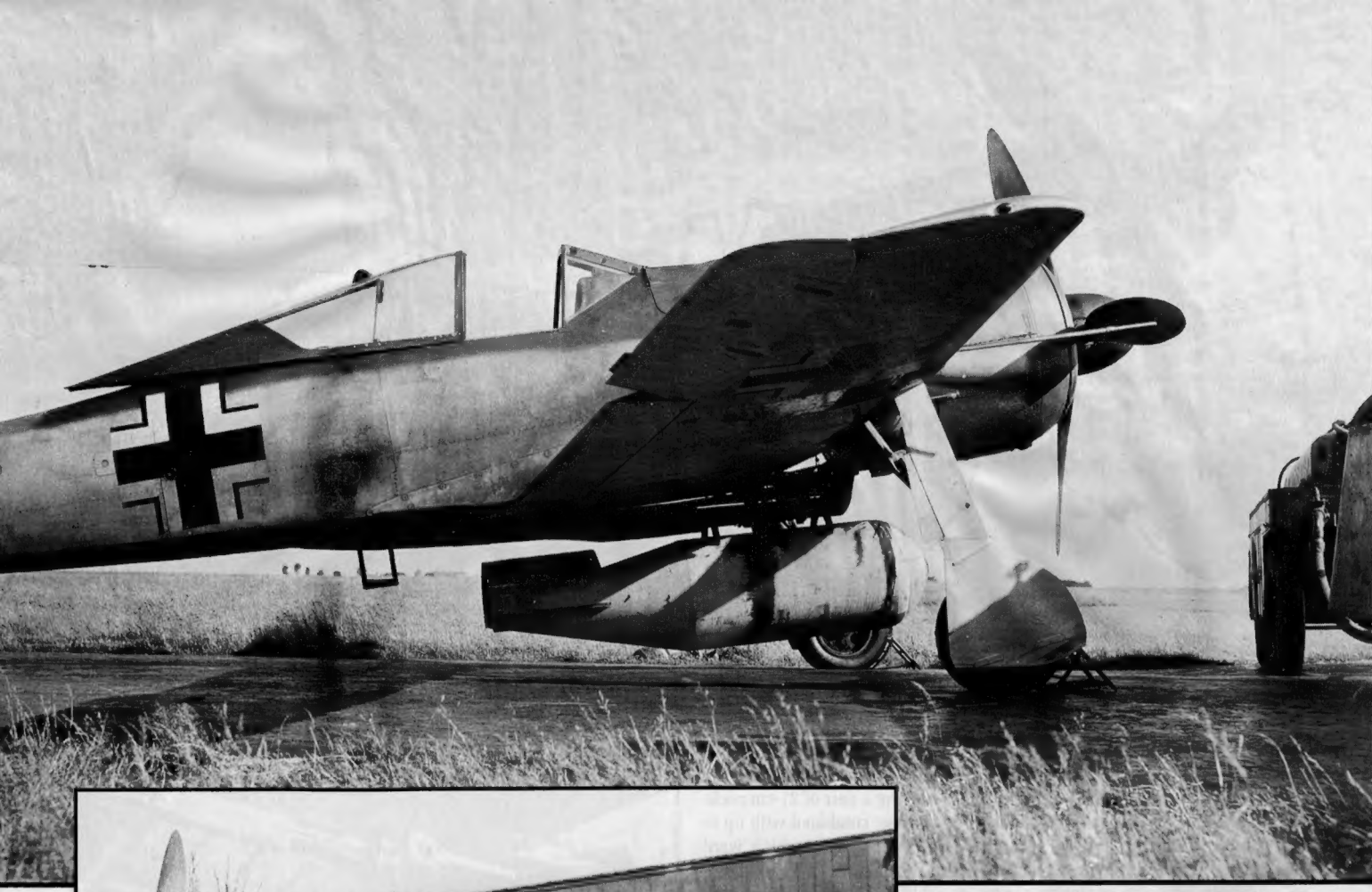
3. With the need for fighter-bombers growing, particularly for service on the Russian front, the majority of Fw 190s produced after 1943, with the exception of special armored formation destroyers, were configured for ground support. Here, Fw 190 V8 service test prototype from 1941, photographed at the Focke-Wulf Marienburg plant, is still proving useful in a fighter- bomber test configuration, carrying four 110 lb. bombs under the fuselage with two under each wing. Nevertheless, the Luftwaffe was facing a dilemma; although it desperately needed fighter-bombers for ground support missions, Allied raids in the west were taking a terrible toll of defending interceptors. During the February, 1944 raids, the Germans were forced to write off 33 percent of their single engined fighters, while losing nearly 18 percent of their operational fighter pilots.


4. One of the more imaginative Fw 190 variants was the A–4/R6, first proposed by General of Fighters, Adolf Galland, who wanted a powerful weapon to break up large Allied bomber formations. The A–4/R6 made its debut over Schweinfurt on October 14, 1943. Carrying a pair of 21-cm rocket mortars under its wings, several squadrons of these, combined with up to 300 standard fighters, claimed 62 out of 228 U.S. bombers, which were unescorted. Fired from distances of 3,200 ft., the nine-ft. long rockets carried an extremely powerful explosive charge, capable of destroying a bomber with a single hit. But once U.S. escort fighters appeared in growing numbers, this type of arrangement was no longer feasible.




5. Close-up of older 20mm Oerlikon cannon installed on outboard wing leading edge of Fw 190, complementing the inboard Mauser MG 151/20. Later in the war, outboard Mausers were paired up in underwing trays.

6. A tropicalized Fw 190A–5/U3 later modified to a Fw 190A–8 pure fighter-bomber, carrying a single 1,100 lb. weapon under ventral fuselage and two 550 lb. bombs under the wings. With up to 900 lbs. of added armor plate, these aircraft dispensed with all armament, except for the inboard Mauser cannon.



**Above: Because it was designed to accept a large number of factory conversion sets, the A–5 airframe featured a revised engine mounting which increased total fuselage length by some six inches. Among the more impressive burdens carried by the reconfigured fighter was this 2,200 lb. bomb, its lower fin deleted to allow for clearance on take off. Others hauled torpedoes and, in most conversions, at least two of the Mauser wing cannon were retained.**

**Left: Heavy-hitting pure interceptor was the Fw 190A–8. It had an additional 25 gallon tank and carried six 20mm Mauser cannon in the wing, the outboard weapons paired up in trays. Another variant replaced these with a single 30mm weapon.**

the elevators were somewhat heavy and the fighter's turning radius was large, due to its high wing loading. If stalled at high speed in a tight turn, it not only dropped its wing violently, but also often inverted itself, spinning out in the opposite direction. The Fw 190 was not a good instrument ship, and at high speed the elevator tab's electric trimming system could literally rip the tail off the airplane if applied suddenly. But it was extremely versatile and could perform many different missions with external stores, including that of torpedo carrying; one reason why it was fitted with more factory conversion sets (*Umrust-Bausatz*, coded by the letter U), as well as field conversion equipment (*Rustsatzen*) than any other Luftwaffe aircraft. An excellent weight carrier for a machine that weighed nearly a half ton less than a fully loaded P–51D Mustang – even in its heavily armored A–8 model – it represented the optimum ground attack airplane for its size. At an overload of 10,000 lbs. it could carry up to 1,000 lbs. of bombs and still retain full armament. And that was a good thing, because of the more than 20,000 produced, fully 8,000 would be employed as dedicated fighter-bombers.

In the first eighteen pre-production machines, armament was a pair of 7.9mm machine guns in the wing roots and another pair in the forward fuselage upper decking, the pilot being provided with a Revi C/12C reflector sight. Although original plans had specified the new Mauser MG 151 cannon in the wing root positions, harmonized for 200 meters instead of 450, its barrels firing through the propeller's arc, the necessary electric synchronization gear was still undergoing development. (In the Messerschmitt Me 109F, the first to carry that weapon, this was no problem, as the gun was mounted centrally, firing through the propeller hub, its shells exiting inside the propeller's arc.) As a temporary measure to increase firepower, older Oerlikon FF 20mm cannon were mounted in the Fw 190's wing, just outboard of the main landing gear legs, again requiring no synchronization.

In the Fw 190A–2, full cannon armament finally appeared, with two synchronized MG 151s in the wing roots, complemented by a pair of FF weapons firing outboard of the propeller, augmenting the light 7.9mm cowl machine guns. The machine guns were each equipped with 1,000 rounds, the MG 151s with 200 rounds

**While heavier armament and larger weapons payloads characterized the operational life of the Fw 190, its lack of range severely restricted loiter time. On the Eastern front this was not a problem, since the majority of missions were flown from just behind the battlefront, some Fw 190 pilots flying up to half a dozen per day. In the west, although Fw 190 pilots were on the defensive and didn't have to fly far in order to intercept Allied bombers, they were definitely at a disadvantage every time they returned to base to refuel and rearm, as their landing strips, no matter how small, were constantly subject to attack. As a result, the Fw 190's basic 500-mile maximum range proved inadequate. Even with two 75 gallon drop tanks, combat radius was less than 500 miles, and in order to retain basic heavy armament, most Fw 190s like the A–8, shown above, operating from an improvised strip in a French wood, were equipped with a single 75 gallon belly tank for the interceptor role. In that configuration, the twin 13mm cowl guns were retained, and the aircraft operated with four 20mm Mauser cannon in the wing. In photo at right, similar aircraft, without drop tank, is rolled from its heavily camouflaged hangar.**

per weapon, fired from box magazines, and the outboard FF 20mm cannon were each given 55 rounds of ammunition, fired from drums. The Revi gun sight was upgraded to the C/12D model, linked to fire-selection equipment that enabled the pilot to choose any combination of weapons; and for his protection an 8mm armored seatback was installed, along with smaller 8mm plates on both sides of the cockpit and above and below the seatback itself. In later models head and shoulder armor was increased to a thickness of 14mm, combined with a sharply sloped windscreen of 50mm armored glass.

Since this article deals mainly primarily with the construction and workings of the various Fw 190 models, and not their service records, the fighter's various components will be discussed in separate headings, augmented by detailed photo captions.

*Engine*

The Fw 190's engine generated 1700 hp. for take off and 1440 hp. at 19,000 ft., with 1500 hp. for climb. Over the course of its general upgrade, compression ratios were steadily increased from 6.5 to 7.22, as were supercharger drive ratios. Beginning with the A–4, a Methanol Water power boost was introduced, the mixture providing extra pull for short bursts of additional speed by acting as an anti-detonate, a system that drastically reduced spark plug life. The BMW 801 itself was provided with a single-stage centrifugal supercharger, with a two speed automatic blower that monitored engine speed, pressure and ignition timing. Driving a variable-pitch, three-bladed VDM propeller, it was supplied by direct fuel injection and cooled by a 12-bladed fan inserted behind the propeller boss and just inside the surrounding lip of the frontal armored cowling. The fan was driven by a reduction gear from the propeller that rotated at nearly three times the propeller's speed. Incoming air built up under pressure, cooled the cylinders, cylinder heads, crankcase accessories and oil, as well as providing the necessary combustion component.

Proper engine cooling would remain a problem throughout the Fw 190's service life, although enough fixes, including outlet louvers, were made so that pilots could live with the problem. During acceptance trials, a number of take offs had to be aborted

when the lowest cylinder in the rear row seized because of inadequate cooling and lubrication. Ironically enough, the strongest section of the cowling, the heavily armored oil cooling ring, often cracked, and the automatic setting mechanism for the VDM propeller frequently failed.

When this reoccurred with fustrating regularity, the engine maker, BMW, and the airframe builders, Focke-Wulf, began finger-pointing, one putting the blame on the other, their arguments growing so heated that, until modifications were made, the Fw 190 was very nearly cancelled.

As advanced and compact as the engine was, its method of mounting was fully as imaginative and performed double duty. The mounting itself was of welded tubular steel and its circular mounting ring, which attached to the engine by means of ten flexible rubber bushings, was hollow, the space serving as a hydraulic fluid reservoir.

*Fuselage*

In keeping with the principle that the new fighter should be simple to maintain, the Fw 190 was built so that parts could be replaced more easily and quickly than they could be repaired. As a result, many of its fittings and items of equipment reflected engineering that was extremely well thought out. The fuselage consisted of two major components – from the firewall to the area behind the pilot's seat – and from there to the empennage. A double-deck box structure was utilized throughout. In the forward section, the upper portion housed the cockpit, the lower portion a pair of fuel tanks, separated by the cockpit flooring. Built of fiber-lined aluminum, suspended by fabric straps, the first tank, containing 61 gallons, was located between the wing spars, just below the flooring at the pilot's feet and was complemented by a larger rear tank, beneath his seat, with a capacity of 64 gallons. Both filled from the right side of the fuselage and were equipped with filler pipe cover plates that lay flush with the fuselage skin and were easily detachable. Each tank also contained a sealed electric pump submerged in the fuel, and these could be accessed from below through a panel attached to the lower fuselage by screws.

Most of the aircraft's weight-bearing interior was made up of "dimple" construction sections, built of two skins fastened together by a single rivet in each dimple. Three heavy locking toggles held each side of the cowling in place, so that even when the engine was being serviced it remained part of the aircraft, the sides folding down for maintenance and fully capable of acting as work platforms. Covering the upper portion of the forward fuselage was a large panel that flipped up and back toward the windshield. Also equipped with toggles, it covered the machine guns mounted on the decking that formed the base of the top fuselage box.

The cockpit canopy, built of 1-3/4 inch bullet resistant glass and operated from the inside by means of a crank, also could be opened in an emergency by pushing down on a small handle located near the crank. This set off a small charge, protected by 14mm armor plate against premature detonation, which jerked the canopy to the rear, far enough to allow the slipstream to pull it off.

The rear portion of the fuselage was buttressed by six Z-shaped stringers on either side of a compartment that housed radio, camera and compass, just to the rear of the wing fairing's trailing edge. It was attached to the fuselage by bolts and reinforced by full width ribbing and a diagonal spar which carried tail wheel loads on the ground and flying surface loads in the air. The rear stabilizer spar was riveted to a forged fitting and the leading edge of the fin's skin was crimped, riveted together and secured by five diamond-shaped self-locking nuts. Aft of the stabilizer spar, the skin was again made up of waffle construction.

*Wing*

The aircraft's wing was built as a single unit, which saved weight but necessitated a complete change if damaged between its detachable tips. Its strongest segment was the center section, which bore the weight of the side engine mounts, landing gear and fittings for the 20mm cannon. The center portion of the front spar was bent forward 14 degrees, permitting the landing gear to retract snugly against it. The rear spar and top wing panels were built as an integral unit and were attached by five top and three bottom ribs. Flaps were metal framed, fabric covered and electrically driven through a maximum extension of 60 degrees. Ailerons were similarly constructed, as was the rudder. The landing gear was also electrically retracted, with a separate motor for each gear, and when it came up or down, so did the tail wheel. Tires were smooth, with horizontal rather than vertical ribbing. In dedicated fighter-bomber models, the wings were stiffened with additional light alloy cross bracing between the ribs, and the rear end of the fuselage was also reinforced.

*Instruments*

One of the most imaginative features of the Fw 190, which featured a basically conventional push-pull rod and cable-type control system, was its command unit throttle quadrant. Located just ahead of the engine mount ring, this hydraulic-electric system automatically adjusted fuel flow, mixture, propeller pitch, ignition and, at higher altitude, supercharger blower, whenever the pilot moved the throttle lever. If the pilot wished to change only propeller pitch setting, without altering the others, a switch next to the throttle enabled him to do so.

More modern than the Messerschmitt 109, and with the advantage of four additional years of improved technology in its layout, in many ways the Fw 190 was as much an improvement over the Me 109 as North American's P–51 Mustang was over the Curtiss P–40. The first order for 100 production Fw 190A–1s was received in January, 1941. They were all completed by October and, by that time, the first Fw 190A–2s were already coming off the Warnemunde assembly line. At the end of the year, a total of 124 fighters had been delivered.

Beginning in the spring and summer of 1942 a number of variations to the basic Fw 190 were tested with different weapon mixes, provisions for drop tanks, bombs, rockets, mortars and even torpedoes, most of them at Arado's Warnemunde facility, which became the weapons capital of the Focke-Wulf empire, and a proving ground for the many sub-types, including fighter-bombers, recon aircraft, bad weather fighters and air superiority machines which would be delivered during the remaining war years.

In May, 1942, the Fieseler plant at Kassel was phased into production and total monthly rates approached 200 by July. From 224 fighters delivered in all of 1941, 1,878 left German factories in 1942, representing forty percent of all Luftwaffe fighters produced that year. With more missions requiring greater loaded weight, the Fw 190's wing was again reinforced the following year and production increased by almost 70 percent in 1943, with 3,200 aircraft being accepted. In July, alone, 325 rolled off assembly lines, but with production of all first line operational aircraft ramping up, Fw 190s now made up just 33 percent of total production.

By 1944, the impressive Arado, AGO and Fieseler combine was joined by Dornier's Wismar factory, while a second important Focke-Wulf plant at Bremen was dispersed due to Allied air attacks, leaving only the main plant at Marienburg. This dispersal eastward, partially out of range of U.S. and British bombers, led to three more shadow facilities coming on-line at Posen, Cottbus and Sorau. However, the damage being caused in these attacks, which severely limited supplies of vital subassemblies, such as tail sections from the Posen facility, forced Focke-Wulf to disperse even more, so much so that the Sorau factory confined itself to reconditioning and revamping the damaged carcasses of Fw 190s shot down or lost in accidents, rebuilding them to fly again. In the course of this program, fully 1,500 were put back into service.

The first G series fighter-bomber with extended range began leaving assembly lines in the late summer of 1943. Its fuselage weapons removed, it had a slightly longer, beefed up fuselage and was equipped with external racks for up to 3,000 lbs. of bombs, as well as external wing racks for additional fuel which gave it a combat radius of 450 miles.

When the first long-nosed Junkers-Jumo powered Fw 190D models emerged in the summer of 1944, they were built at the Cottbus factory, but production aircraft were completed at Marienburg, which was still turning out eight per day at war's

Above: Preparing to fly Ju 87 Stuka escort on Eastern front in July, 1944, this Fw 190A–6 from JG 54 is rearmed and refueled for another sortie. Naked from the waist up on a hot day, pilot is checking his radio leads with help of a smocked technician, while a mechanic works on cowling. Hidden behind the aircraft is a fuel truck. That's a parachute pack on the port stabilizer.

Left: Ground attack Fw 190F–8 from SG 5 is shown with its outboard cannon deleted and ETC 500 ventral bomb rack for large belly-mounted weapon.

end. Between 650 and 700 D models were completed, part of nearly 11,500 Fw 190s – not counting rebuilds – which were delivered in 1944, an increase of 375 percent over the previous year. At the end of 1944, a total of some 16,725 Fw 190s had been produced, and although records for 1945 remain uncertain, at least 2,700 more made their way to Luftwaffe units. This number does not include perhaps 1,500 additional machines found on assembly lines or at depots in various stages of construction.

More detailed construction information will be found in the photo captions.

Below: Had the war continued, even with newer and more advanced models of the Focke-Wulf design, namely the long-nosed D and the later Ta 152, the older workhorse Fw 190 would still have undergone even more changes. This is the prototype test version of the A–9 series. Conceived as a ram interceptor, it was given heavily armored wing leading edges (ostensibly designed to survive all but direct ramming, as well as shaking off defensive fire from enemy bombers). It had improved supercharger gear ratios and a more powerful version of the BMW 801 engine delivering 2000 hp. for take off. It did not advance beyond the prototype, once the Fw 190D alternative exhibited more promise.